

FILE NO. 2-1648B

DATE: April 7, 2000

CODE APPLICATION NOTICE

1648B, DIV III-R, Chapter 16B, Part 2, 1998 California Building Code

SUBJECT

APPROVAL DATE

Seismic Retrofit of structure from SPC-1 to SPC-2

August 17, 2000

Seismic Retrofit of Single Story Hospital Buildings Utilizing,
Wood Frame or Light Steel Construction

March 20, 2001

**SEISMIC RETROFIT OF SINGLE STORY HOSPITAL BUILDINGS UTILIZING,
WOOD FRAME OR LIGHT STEEL CONSTRUCTION**

CODE SECTION: Section 1648B-Method B, DIV III-R, Chapter 16B, Part 2, 1998 California Building Code

1648B.1 *The existing or retrofitted structure shall be demonstrated to have the capability to sustain the deformation response due to the specified earthquake ground motions. The engineer shall provide an evaluation of the response of the existing structure in its current configuration and condition to the ground motions specified. If the building's seismic performance is evaluated as satisfactory and the peer reviewer(s) [OSHDP 1: and the enforcement agent] concurs, then no further engineering work is required. When the evaluation indicates the building does not meet the objective of the Division III-R safety goals [OSHDP 1: and the applicable structural seismic performance (SPC) and nonstructural seismic performance (NPC) requirements,] then a retrofit and/or repair design shall be prepared that yields a structure that meets the life-safety [OSHDP 1: and operational] performance objectives of Section 1640B of Division III-R and reflects the appropriate consideration of existing conditions. Any approach to analysis and design may be used that yields a building of reliable stability in the prescribed design earthquake loads and conditions. The approach shall be rational, shall be consistent with the established principals of mechanics, and shall use the known performance characteristics of materials and assemblages under reversing loads typical of severe earthquake ground motions.*

Exception: *Further consideration of the structure's seismic performance can be waived by the Enforcement Agent if both the engineer-of-record and peer reviewer(s) [OSHDP 1: and/or Enforcement Agent] conclude that the structural system can be expected to perform at least as well as required by Division III-R provisions without completing an analysis of the structure's conformance to these requirements. A detailed report shall be submitted to the responsible Enforcement Agent that presents the reasons and basis for this conclusion. This report shall be prepared by the engineer of record. The peer reviewer(s) [OSHDP 1: and/or Enforcement Agent] shall concur in this conclusion and affirm to it in writing.*

PURPOSE:

The purpose of this CAN is to provide an acceptable approach for seismic retrofit of single story hospital buildings utilizing wood frame or light steel frame construction from SPC-1 level to SPC-2 level. These buildings are typically classified as "Building Type 1-Wood, Light Frame" or "Building Type 2- Wood, Commercial and Industrial" as specified in Section 2.2.3, Article 2, Chapter 6, Part 1, Title 24. This methodology does not apply to single story hospital buildings utilizing wood frame or light steel frame construction with roofing membrane (shingles, tile, etc.) weighing more than 10 psf.

INTERPRETATION:

The relative safety of single story light wood frame or light steel frame constructed buildings has long been recognized. These types of buildings were specifically excluded from the definition of “Hospital building” when used as a skilled nursing or intermediate care facilities [Health and Safety Code Section 129725(b)(2)]. Even though by calculation these buildings may evaluate as an SPC-1, we know from past experience that these building types survive earthquakes without collapse, provided that the building has certain attributes. These attributes include braced cripple walls, adequate connection to the foundation, and, in the case of larger light frame structures, regularly and closely spaced sheathed walls that extend from the foundation to the roof. The SPC-2 criteria is that “These buildings may not be repairable or functional but will not significantly jeopardize life” following strong ground motion. Although these buildings do not normally collapse, there are factors that may jeopardize life as they respond to an earthquake.

Therefore, single-story Building Type 1- Wood, Light Frame structures, and single-story “Building Type 2- Wood, Commercial and Industrial” structures, evaluated per Section 1.3.3, Article 1, Chapter 6, Part 1, Title 24, as an SPC-1 may be placed in category SPC-2 provided the following items have been mitigated and construction completed prior to January 1, 2008:

1. **Cripple Walls per Section 5.6.4, Article 5, Chapter 6, Part 1, Title 24:** This deficiency is considered mitigated with the addition of structural panel sheathing to the inside face of stud of the cripple wall. In addition, single-story hospital buildings utilizing wood frame or light steel frame construction with a floor area greater than 5,000 square feet, this deficiency is considered mitigated provided that the interior shear and or bearing walls are supported below the floor by cripple wall studs with structural panel sheathing and sill plates bolted to the foundation. An acceptable methodology for performing this work is the prescriptive procedure for the repair and/or retrofit of existing buildings specified by the Uniform Code for Building Conservation (UCBC), Appendix Chapter 6.
2. **Foundation Bolting per Sections 8.4.7, Article 8, Chapter 6, Part 1, Title 24:** This deficiency is considered mitigated with the addition of drilled-in anchors to provide the minimum bolt spacing per the structural evaluation procedure.
3. Vertical lateral-force resisting elements must be provided parallel to the length of the building so that, in each resisting direction, there is at least one vertical lateral-force-resisting element within 35 feet of any portion of the building length. Existing sheathed stud walls that extend from the foundation to the roof diaphragm shall be considered to meet this requirement. In buildings made up of multiple diaphragm segments, the vertical lateral-force resisting elements shall be directly attached to the diaphragm segment.

4. Where existing sheathed stud walls do not extend from the ceiling to the roof at a maximum spacing of 35 feet in each direction, existing walls shall be extended to the roof to obtain the maximum spacing of 35 feet. The 35 foot spacing is based on capacities of typical light frame wood building shear walls subject to the estimated earthquake demands calculated from Article 2, Chapter 6, Part 1, Title 24. When substantiated by structural calculations, the 35 feet may be increased when the shear capacity and overturning stability of the shear walls is adequate. The extended wall portion in the ceiling space shall be anchored to the wall below at each end to resist uplift forces from the design seismic lateral load. The new studs shall be spaced at a maximum of 24 inches on center.
5. Bearing and non-bearing stud walls within the ceiling to roof space designated to resist in-plane seismic lateral forces shall be covered with sheathing on at least one side with nailing sufficient to resist the in-plane design seismic lateral force and to transfer that shear force from the roof diaphragm to the sheathed wall portion below. Where the existing sheathing of the wall below the ceiling is gypsum board or plaster, the new structural sheathing in the ceiling to roof space shall consist of gypsum board. The maximum shear capacity of the new gypsum board sheathing shall not be taken to be greater than 100 pounds-per-linear foot (5d nails at 7 inches on center). The maximum shear capacity of walls with gypsum board sheathing on two sides shall not be taken to be greater than 200 pounds-per-linear foot (5d nails at 7 inches on center).

The maximum height (from roof to floor)-to-width ratio of the stud wall shall not exceed 1:1 in order to be considered as resisting the in-plane seismic lateral force. This limitation is based on the stability of the shear wall considering that there are no designed holdown anchors at the ends of the wall at the floor level.

REASON:

This Code Application Notice is provided to address the recognized performance of these building types. It is the Office's interpretation of Section 1648B.1 which states "Any approach to analysis and design may be used that yields a building of reliable stability in the prescribed design earthquake loads and conditions".

ORIGINAL SIGNED

Kurt A. Schaefer

03/20/01

Date

SEISMIC RETROFIT OF STRUCTURE FROM SPC-1 TO SPC-2**CODE SECTION:** Section 1648B.1, 1998 California Building Code***1648B-Method B***

1648B.1 The existing or retrofitted structure shall be demonstrated to have the capability to sustain the deformation response due to the specified earthquake ground motions. The engineer shall provide an evaluation of the response of the existing structure in its current configuration and condition to the ground motions specified. If the building's seismic performance is evaluated as satisfactory and the peer reviewer(s) [OSHDP 1: and the enforcement agent] concurs, then no further engineering work is required. When the evaluation indicates the building does not meet the objective of the Division III-R safety goals [OSHDP 1: and the applicable structural seismic performance (SPC) and nonstructural seismic performance (NPC) requirements,] then a retrofit and/or repair design shall be prepared that yields a structure that meets the life-safety [OSHDP 1: and operational] performance objectives of Section 1640A of Division III-R and reflects the appropriate consideration of existing conditions. Any approach to analysis and design may be used that yields a building of reliable stability in the prescribed design earthquake loads and conditions. The approach shall be rational, shall be consistent with the established principals of mechanics, and shall use the known performance characteristics of materials and assemblages under reversing loads typical of severe earthquake ground motions.

Exception: *Further consideration of the structure's seismic performance can be waived by the Enforcement Agent if both the engineer-of-record and peer reviewer(s) [OSHDP 1: and/or Enforcement Agent] conclude that the structural system can be expected to perform at least as well as required by Division III-R provisions without completing an analysis of the structure's conformance to these requirements. A detailed report shall be submitted to the responsible Enforcement Agent that presents the reasons and basis for this conclusion. This report shall be prepared by the engineer of record. The peer reviewer(s) [OSHDP 1: and/or Enforcement Agent] shall concur in this conclusion and affirm to it in writing*

PURPOSE:

The purpose of this CAN is to provide an acceptable approach for seismic retrofit of a structure from an SPC 1 level to an SPC 2 level only by modifying the building such that it will pass the detailed evaluation procedures without any unmitigated "False" responses to the evaluation statements. This methodology does not apply to hospital buildings utilizing "Building Type 8-Concrete Moment Frame" as specified in Section 2.2.3, Article 2, Chapter 6, Part 1, Title 24.

INTERPRETATION:

Analysis and retrofit of existing structures for earthquake loading is complex. Many different approaches to linear and non-linear static, pseudo-dynamic and dynamic analytical procedures have been developed and used in particular cases. However, while there is no consensus on a single acceptable analytical procedure for all circumstances, in general, older buildings with certain attributes have performed adequately in past earthquakes. The Title 24 requirements (Chapter 6, Part 1) for the seismic evaluation of existing hospital buildings identify structures with these desirable attributes. By definition, a building that meets the requirements of SPC-2 outlined in the evaluation procedures meets the requirements for basic life safety. Therefore an acceptable approach for seismic retrofit of a structure from SPC-1 to SPC-2 would be to modify the building, such that it will pass the evaluation procedure without any unmitigated “False” responses to the evaluation statements.

Care must be taken when this approach to retrofit is followed. The evaluation procedures contain many statements that can be classified as “triggers”. These include the “quick check” procedures, and evaluation statements that focus on aspect ratios of structural elements (for example, statements covering overturning and boundary elements in concrete shear walls). Evaluation statements of this nature trigger a detailed analysis of the structure, or may automatically place a building in SPC-1 category. An effective seismic retrofit strategy not only focuses on the evaluation statements, but also includes a full analysis of the structure, to ensure that a complete load path, of sufficient strength, ductility, and stiffness is present.

The evaluation procedure shall be used to identify the principal weaknesses of the structure. Existing structural elements shall be reinforced, and/or new structural elements added, to eliminate or mitigate “False” responses to the evaluation statements. ~~These new or reinforced elements shall be proportioned to meet the force and displacement requirements of the 1998 CBC.~~ All existing and new or modified elements shall be capable of resisting the ~~reduced~~ design forces and displacement requirements specified in the seismic evaluation procedure, Article 2, Chapter 6, Part 1, Title 24. The detailing of new structural elements shall meet the requirements of the 1998 CBC. Detailing of modified or reinforced structural elements shall meet the provisions of the 1998 CBC. Alternatively the detailing may be substantiated by full scale cyclic testing or by advanced analytical techniques to meet the ductility demand of 4.0 as specified in FEMA 273, Table 6-5 and applies to all types of Lateral Force Resisting systems for the purpose of these regulations.

A detailed analysis of the building shall be performed. Where evaluation statements refer to the “quick check” procedure of Section 2.4.7, Article 2, Chapter 6, Part 1, Title 24, a detailed analysis of the building, including determination of element shear and flexural demands and capacities shall be performed. Where “quick checks” for story drift are required, a detailed three-dimensional analysis of the building will be performed to obtain the story drifts. Allowable story drift is specified in Section 2.4.4, Article 2, Chapter 6, Part 1, Title 24.

REASON:

The retrofit design methodology outlined in Figure 1 provides a simplified approach for strengthening buildings to the SPC-2 performance level. The methodology is most suitable for structures with clearly defined deficiencies. Buildings with systemic problems, for example, nonductile concrete frames or URM bearing wall structures, will not benefit from the application of the simplified technique. Structures with systemic deficiencies require the addition of a new, essentially complete lateral force resisting system of sufficient strength and ductility. Division IIIR, Method A, or the advanced analytical techniques available under Method B will generate more efficient and cost effective strengthening solutions for these buildings.

ORIGINAL SIGNED

08/17/00

Kurt A. Schaefer

Date

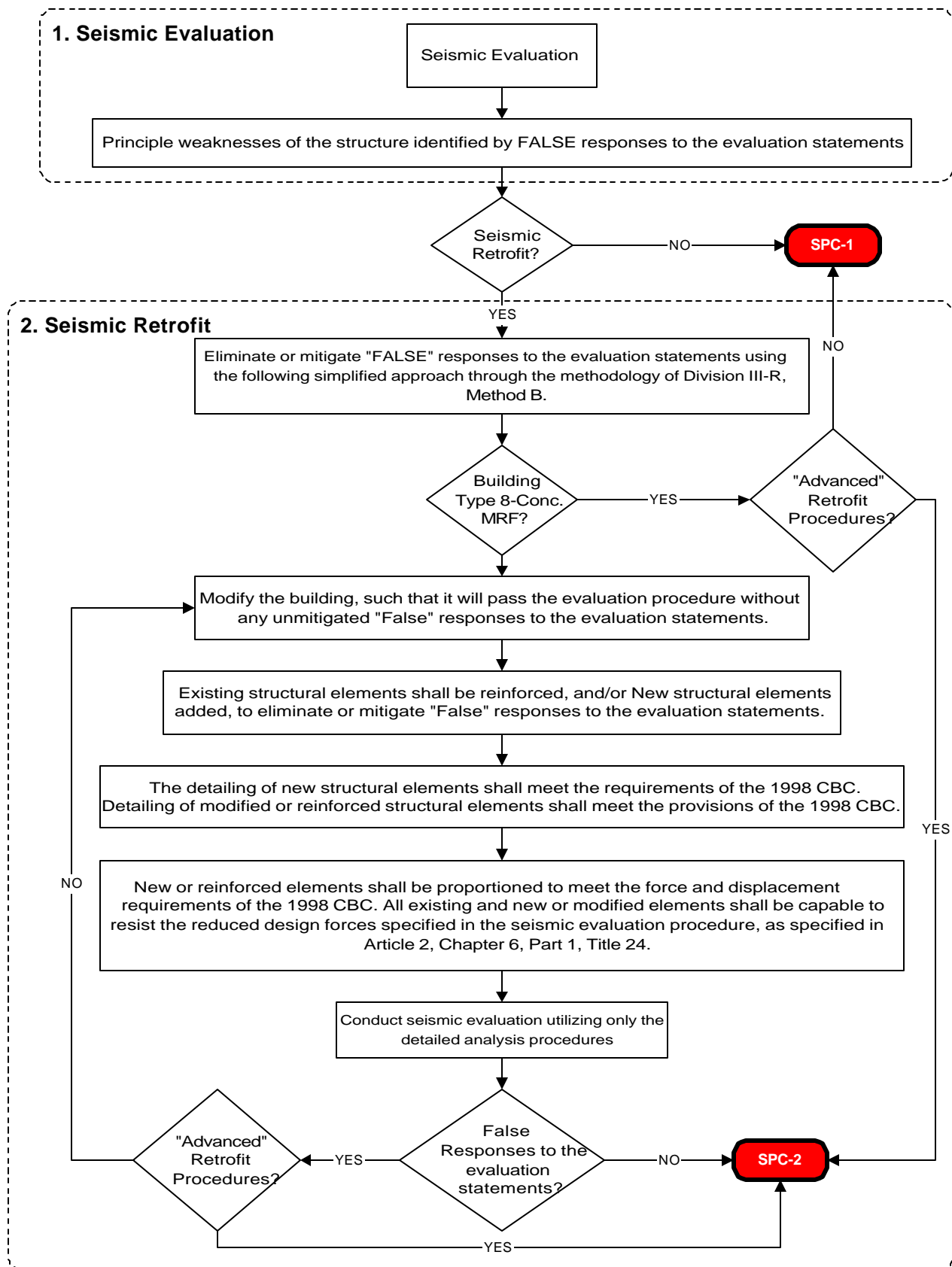


Figure 1 An Acceptable approach to retrofit a Hospital Building from an SPC 1 Level to an SPC 2